QUALIFICATION OF PHOENIX LANDER HERITAGE ION-SELECTIVE ELECTRODES FOR LONG DURATION SPACE EXPLORATION.

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Introduction: The 2007 Phoenix Lander mission characterized the regolith in the northern plains of Mars with the purpose of assessing the habitability of the landing site[1]. The results from this mission contributed to our understanding of the chemistry of the Martian surface, as well as being a first step toward preparing for human exploration. Included in the Phoenix Lander's instrument suite was an electrochemical sensor array with polymeric ion-selective electrodes (ISE) as part of the Wet Chemistry Lab (WCL) experiments[2]. The WCL ISE experiments successfully determined the pH, primary cation concentrations, and were the first to detect perchlorate in the Martian regolith[3,4].

ISEs are simple, low-cost sensors with a large dynamic range and minimal power requirements. Their demonstrated success during the Phoenix mission makes the heritage WCL ISEs well suited for continued use in space exploration, both in robotic and human missions. Due to the simplicity of their design it is likely that the WCL ISEs are robust enough for a wider range of applications than initially conceived. These ISEs have already demonstrated their robustness to sample volume through incorporation into a 100µL array, which is 250 times smaller than used during the Phoenix mission[5].

The heritage design includes a hydrogel inner filling solution which is prone to dehydration during dry storage, and a polymeric membrane containing lipophilic ion-exchangers which may be damaged during long-term or high dose radiation exposure. We are qualifying the limits of these heritage ISEs in order to understand the range of their potential as a spaceflight technology.

Experimental: The WCL ISEs are being stored at relative humidity (RH) < 0.5% and are tested at regular time intervals over the course of a year to assess the effect of dehydration on their performance. Prior to calibration after dry storage ISEs are conditioned by soaking in a 0.1 M NaCl solution for 30 minutes until the potential stabilizes. Radiation testing up to 300 krad will be performed to address the potential for radiation to damage the polymeric membrane components. Simultaneously, we are designing next generation solid-contact ion-selective electrodes (SC-ISE) and qualifying these alongside the heritage WCL ISEs to further expand the range of potential applications for this technology.

Results: Initial dry storage results show that after 1 month at < 0.5% RH the heritage WCL ISEs perform comparably to their initial performance despite observable dehydration of the inner hydrogel solution.

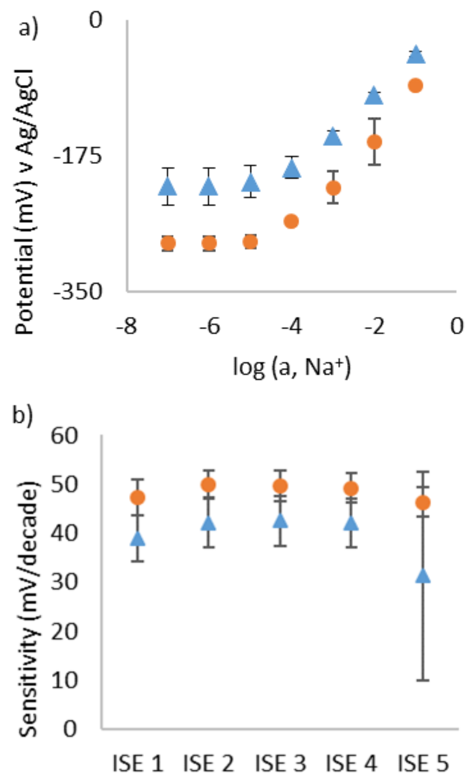

Figure 1: (a) Typical calibration curve and (b) comparison of calibration slopes from 10µM to 100mM activity sodium for WCL ISEs before (triangle) and after (circle) 1 month storage at <0.5% RH. Data points represent the average of 5 calibrations, and error bars are the standard deviation

References:

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